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National Gypsum

Water Pumping System at National Gypsum's Milford Quarry

Our Task

- National Gypsum's open pit mine spans over 3 km². Run-off water collects and needs to be pumped out to allow gypsum to be mined
- An unstable rock face requires a water reservoir and pump house removed on the 1st level
- Design a new pumping system to match the functionality of the current system

Mine Water Supply

- Filled into a water truck to spray on mine roads for dust control
- Sprayed through nozzles at the gypsum crusher buildings for dust control
- Supplied to truck washing pad to clean mine equipment using wash turrets
- Pumped into storage tanks to be used in the mine offices

The Design

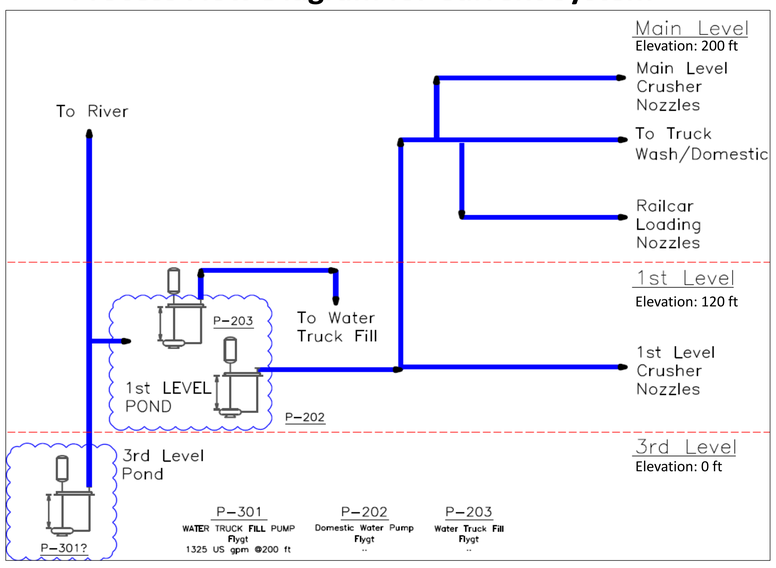
- The current 1st level pump will be moved to 3rd level for dewatering and water-truck filling purposes
- The new truck filling station will be housed on the opposite side of the road. A control panel will direct water from the 3rd level pump into this fill station and into the truck
- To meet pressure requirements at each of the crushers and the rail car building, booster pumps will be installed at each site
- A Variable Frequency Drive (VFD) will control the speed of each pump

Calculations

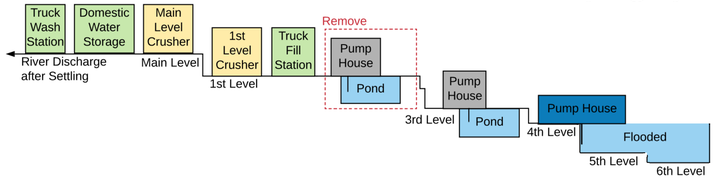
- Head loss due to pipe friction estimated using Hazen-Williams equation
- Flow losses a function of flow, pipe diameter and pipe material constant
- To determine nozzle flow rate estimates, obtained iteratively using Bernoulli's Eq.
- Similar nozzle product spec sheet gives flow rate of ~3 gpm at 60 psi

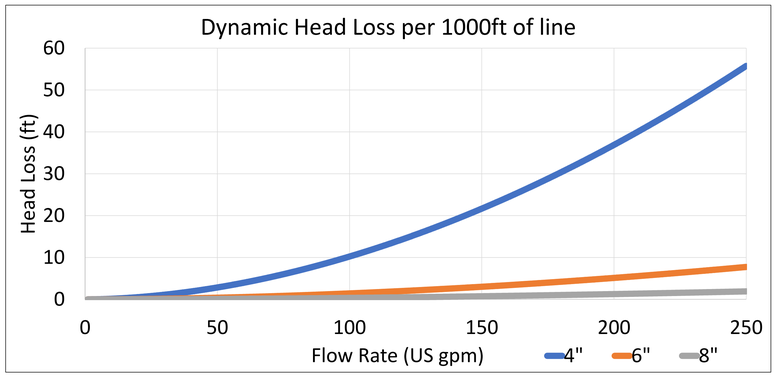
Main Level of the Quarry Looking at 1st Level Crusher

Process Flow Diagram for Current System



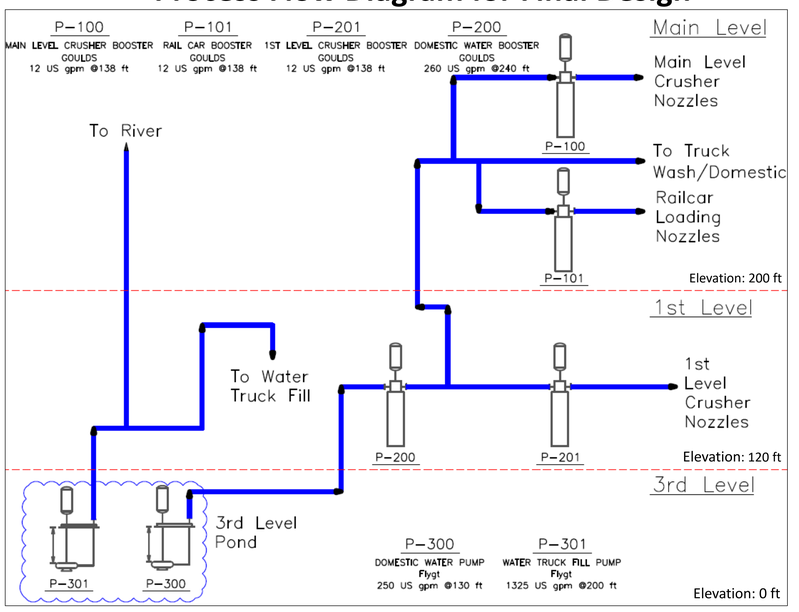
Side View Schematic of the Current Pumping System





Overhead View of Required Changes to the System

Process Flow Diagram for Final Design



Bill of Materials

Type	Part Description	Supplier	Order Qty	Unit Type	Unit Price	Cost
Pipe	6", HDPE, 125psi	Wolseley	600	ft	$8.55	$5,130.00
Pipe	8", HDPE, 125psi	Wolseley	800	ft	$13.95	$11,160.00
Pump	1 hp Booster - Multi Stage Pump	Gould	3	each	$1,200.00	$3,600.00
VFD	VFD for 1 hp Booster	Gould	3	each	$900.00	$2,700.00
Filter	DV/DT Filter for 1 hp Booster	Gould	3	each	$600.00	$1,800.00
Pump	15 hp Inline Pump - 6.125" Dia Imp	Gould	1	each	$4,700.00	$4,700.00
VFD	VFD for 15 hp Inline	Gould	1	each	$3,168.00	$3,168.00
Filter	DV/DT Filter for 15 hp Inline	Gould	1	each	$1,783.00	$1,783.00
Pump	15 hp Submersible Pump	Xylem	1	each	$13,385.00	$13,385.00
VFD	VFD for 15 hp Submersible	Xylem	1	each	$3,168.00	$3,168.00
Filter	DV/DT Filter for 15 hp Submersible	Xylem	1	each	$1,783.00	$1,783.00
Instrument	Inline Flowmeter for 6" HDPE pipe	Siemens	1	each	$6,250.00	$6,250.00
Valve	6" Check Valves	Xylem	2	each	$1,175.00	$2,350.00
Instrument	Pressure Transmitter	Siemens	5	each	$375.00	$1,875.00
Valve	2" Butterfly Valve (w/ lever)	Bray	14	each	$187.50	$2,625.00
Valve	2" Pressure Reducing Valve	Singer	3	each	$2,250.00	$6,750.00
Pipe	6" HDPE Elbows, 90 degree	Wolseley	5	each	$104.00	$520.00
Pipe	8" HDPE Elbows, 90 degree	Wolseley	5	each	$190.00	$950.00
Valve	6" Y-Valve	Flowteck	1	each	$16,250.00	$16,250.00
					Total Cost	**$89,947.00**

Requirements

- Provide 12 US gpm at 60 psi to dust control buildings
- Provide 200 US gpm of water to truck wash pad
- Water truck must be filled in 10-15 minutes at a location on the 1st level

Advantages of New Design

- Use of third level dewatering pump to also fill water trucks avoids purchase of large pump
- 3 stages of pumping reduces head required for a single pump, giving greater flow rate flexibility
- New pump-house on 1st level also acts as a fill station for water trucks

Design Considerations

- Use of existing equipment prioritized to reduce costs
- Minimal design footprint on third level desired
- Minimize number of lines needed
- Large static head from third to first level difficult to combine with large range of flows

Safety Considerations

- Check valves prevent the back drive of elevated water
- Bypass lines and shut off valves would allow water to flow around pumps during maintenance
- Since commercially-built submersible pumps are used, oil leak hazards are not a great concern
- Lock-out/Tag-out procedures are recommended to eliminate the risk of a pump turning on during maintenance
- A safe-filling procedure would be recommended to ensure workers are out of the line-of-fire of the high-flow truck fill output

References

- Hibbeler, R. C. (2018). *Fluid Mechanics* (2nd ed.). Hoboken, NJ: Pearson
- Page Bloomer Associates. (2015). *Pump Efficiency Guidelines* [PDF File]
- Global Gypsum (2015). *National Gypsum hopes to expand the 'largest quarry in the world'*.